I, JONATHAN J. RHODES, declare and state as follows:

<u>Qualifications</u>

1. My name is Jonathan J. Rhodes. I am a hydrologist with more than 30 years of experience, with a B.S. in hydrology from University of Arizona, a M.S. in hydrology and hydrogeology from University of Nevada-Reno and I finished all required academic work toward a Ph.D. in forest hydrology at the University of Washington. Since 2001, I have worked as a consulting hydrologist for a variety of clients, including county and tribal governments in Oregon, Washington, and Idaho. Prior to that I worked for more than 12.5 years at the Columbia River Inter-Tribal Fish Commission (CRITFC), where I served as Senior Scientist-Hydrologist. My professional experience includes work for tribal, federal, state, county, and city governments, universities, and non-profit groups in eight western states.

2. During my tenure at CRITFC, our work with the U.S. Forest Service (hereafter "USFS") provided the groundwork for most of the substantive watershed protection measures ultimately adopted by the USFS and U.S. Bureau of Land Management (hereafter "USBLM") in two combined agency management strategies designed to reduce the decline in habitat for anadromous and resident salmonids, including steelhead, chinook salmon, and cutthroat trout, in the Columbia River basin: "Implementation of Interim Strategies for Managing Anadromous Fish-Producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California" (USFS and USBLM, 1995).

3. Most of my work has over the past 24 years has focused on the effects of current and proposed uses of land and water on water quality, streams and habitats for native trout and salmon. For more than 20 years, I have monitored the impacts of the public land management on watersheds and aquatic systems.

4. I have co-authored numerous papers on the effects of logging (including thinning), roads, and related activities on watersheds and aquatic systems published in peer-reviewed scholarly journals (e.g., Espinosa et al., 1997; Beschta et al., 2004; Karr et al., 2004; Rhodes and Baker, 2008). I am the primary author of (Rhodes et al., 1994), a peer-reviewed report developed under contract at the behest of National Marine Fisheries Service. Rhodes et al. (1994) includes a comprehensive review of available scientific information on the effects of logging and roads on water quality and salmonid habitat. This report has been cited in numerous scholarly journals, as well as many U.S. Forest Service scientific assessments. For instance, the U.S. Forest Service's scientific assessment of management impacts on interior Columbia Basin national forests authored by USFS research scientists (USFS and USBLM, 1997a) cites Rhodes et al. (1994) more than 10 times. Similarly, the USFS's synthesis of scientific information on roads (Gucinski et al., 2001), authored by USFS research scientists, cites Rhodes et al. (1994) six times regarding the impacts of roads on soils, watersheds, and aquatic systems.

5. I am also the primary author of a peer-reviewed paper examining the impacts of fine sediment levels, including that contributed by roads, on salmon survival in streams in the Blue Mountains of Oregon (Rhodes and Purser, 1998) and co-author of a report providing the results of a government-funded study of sediment sources and their impacts on salmon survival in the Stillaguamish River in western Washington (Purser, et al. 2009). I have published many other reports related to the effects of land and water use on salmon habitat, stream sedimentation, and water quality. I have served as a peer-reviewer for the Open Forest Science journal, North American Journal of Fisheries, and an international symposium on the effects of forest management and streams for papers related to soil erosion and stream sedimentation of salmonid habitats. A true and correct copy of my curriculum vitae is included with this declaration.

Information Reviewed

6. I reviewed the Final Environmental Impact Statement (FEIS) for the Big Thorne Project (Project) Thorne Bay Ranger District, Tongass National Forest (TNF), dated June 2013, and the Project's Record of Decision, and its appendices, dated June 2013.

7. I also reviewed other pertinent scientific literature. The list of this literature is too lengthy to list here, so I have listed it separately at the end of this declaration. I also drew on my professional judgment and experience in preparing this declaration.

Scope of Review

8. I submit this information to explain how the FEIS failed in many ways to reasonably assess the Project's effects on watershed conditions and aquatic resources, including stream conditions, riparian areas, water quality, and salmonid habitats and populations. I describe some of the numerous ways that FEIS did not reasonably incorporate and make known available scientific information on the nature, intensity, and duration of the likely direct, indirect, and cumulative effects of the Project on large woody debris (LWD), water temperature, stream sedimentation and channel form, peak flows, salmonid habitats, and water quality. I also discuss how the FEIS failed to reasonably describe and assess existing watershed and aquatic impacts and aspects of the Project's action alternatives that are likely to cause significant and persistent harm to affected watersheds, riparian areas, salmonid habitats and populations, and streams.

Discussion

The FEIS fails to adequately assess and make known the impacts of existing roads and proposed Project road activities on watersheds, riparian areas, streams, and fish habitats.

The FEIS does not properly assess road-stream connectivity and consequent impacts on peak flows and sediment delivery from roads.

9. The FEIS failed to reasonably describe the hydrologic connectivity of the existing road network and proposed roads under the Project. This is a severe defect because proper assessment of road-stream connectivity is essential to adequately evaluating cumulative peak flow and sediment delivery impacts of roads under existing conditions and the action alternatives. Notably, having conducted road connectivity surveys (e.g., Rhodes and Huntington, 2000) over many years in many areas, I can attest that such surveys are straightforward and relatively easy to do and analyze.

10. The FEIS's assessment of existing road crossings and road crossings proposed under the action alternatives on Class I through Class III streams is not an adequate surrogate for assessing road-stream connectivity, for several reasons. First, although road crossings certainly act as points of road-stream connectivity (Kattlemann, 1996; Rhodes and Baker, 2008; Plumas National Forest, 2010), roads are also directly connected to streams with considerable frequency at other features, including drainage to hillslopes near streams, ditches, and gullies below drainage diversions (Wemple et al., 1996; Rhodes and Huntington, 2000; Gucinski et al., 2001; Great Lakes Environmental Center (GLEC), 2008). Roadside ditches collect and concentrate road runoff and route it considerable distances to discharge points to streams, such as culverts that discharge to gullies, increasing the length of road that delivers sediment-laden runoff to streams. USFS and USBLM (1995) noted that channelized flows of water and sediment, such as those in gullies below road ditch drainage features, can travel several hundred feet downslope.

11. Roads typically contribute water and sediment to streams via hydrologic connectivity at points other than stream crossings when they are relatively close to streams. The Clearwater National Forest (2003) noted that roads within 300 feet of streams likely contribute some runoff and sediment to streams. Sediment detention below road runoff diversions is

limited and quickly exhausted, resulting in the delivery of sediment to streams from road runoff diversions near streams, particularly in areas with high levels of precipitation, such as the Pacific Northwest, (which has a similar precipitation levels to the Project area) as noted in the USEPA-commissioned assessment of road Best Management Practices (BMPs) and the water quality impacts of roads (GLEC, 2008), although this is not assessed or divulged in the FEIS.

12. The number of road crossings on Class I through III streams under existing conditions and the action alternatives, as presented in the FEIS (p. 3-291) and ROD (p. 39), does not provide an index of road-stream connectivity under existing conditions or the alternatives, because it fails to address other points of stream-road connectivity, such as drainage features and roads close to streams. The FEIS completely fails to make known the amount of road that is relatively proximate (e.g., within 300') to *all* streams under existing conditions and the action alternatives; such road information could, at least, provide an index of road connectivity at the subwatershed and watershed scales. Therefore, the FEIS does not provide an index of road-stream connectivity, which is critical to assessing the direct, indirect, and cumulative effects of the existing road network combined with those of the action alternatives.

13. The FEIS's failure to assess and disclose the amount of roads that are hydrological connected to streams at locations is a severe defect because it is likely that a significant fraction of the existing road network is hydrologically connected to streams and that a significant fraction of roads proposed for reconstruction, construction, and elevated use under the alternatives will also be hydrologically connected to streams. The magnitude of the average annual precipitation in the Project area is high, which serves to increase the amount of connectivity between roads and streams, including at areas other than stream crossings. The USFS's own summary of scientific information on roads (Gucinski et al.; 2001) noted, "As

storms become larger or soil becomes wetter, more of the road system contributes water directly to streams." MacDonald and Larsen (2009) provide data corroborating that the amount of roads contributing sediment and runoff to streams increases with increasing mean annual precipitation. It is likely that more than 50% of the existing road network is connected to streams and that a similar fraction roads proposed for construction and reconstruction will be connected to streams, even if engineered drainage diversions are in place on roads, based on the relationship between road-stream connectivity and mean annual precipitation in MacDonald and Larsen (2009)[1] together with a mean annual precipitation of 120 inches for Project area. Using the same information, it is likely that an even higher fraction of roads without engineered drainage structures within the Project area are connected to streams. It is highly likely that a significant fraction of this connectivity occurs at locations other than stream crossings, based on surveys in areas with lower levels of mean annual precipitation (e.g., Wemple et al., 1996; Rhodes and Huntington, 2000).

14. A second reason that the FEIS's (p. 3-291) estimate of stream crossings on Class I through Class III streams fails to provide a reasonable index of road-stream impacts is that it completely omits the number of road crossings on Class IV streams under existing conditions and by roads subject to elevated use, reconstruction, and construction under the action alternatives. This is a severe defect because these smaller headwater streams collectively provide much of the cumulative sediment and water to downstream fish habitats, due to the extent and position of these smaller headwater streams (Moyle et al., 1996; USFS and USBLM, 1997a). Thus, it is necessary to assess cumulative impacts of road connectivity with Class IV streams, because streamflow and fine sediment impacts to these streams are readily and rapidly

[1] MacDonald and Larsen (2009) explicitly note that "In the absence of local data, the relationship shown in Figure 1 [in the paper] can be used to estimate the proportion of unpaved roads that are likely to be delivering runoff and sediment to the stream channel network."

translated downstream, cumulatively affecting downstream fish habitats (Rhodes et al., 1994; Moyle et al., 1996; USFS and USBLM, 1997a).

15. Although the TNF's stream class typing assumes that individual Class IV streams have little immediate effect on downstream water quality or fish habitat capability (FEIS, p. 4-31), the FEIS provides no sound scientific rationale for this assumption. However, this assumption regarding Class IV streams fails to reflect the available scientific information regarding the *cumulative* importance of smaller headwater streams, typed as Class IV. For instance, the USFS's own scientific assessment, USFS and USBLM (1997), noted that smaller, non-fish bearing perennial and intermittent streams:

a) are more affected by sedimentation from sediment production accelerated by upslope activities than larger streams (pp.1365 to1366);

b) are a primary source of sediment supplied to fish bearing streams (p. 1366);

c) typically comprise the majority of the channel network and "...therefore strongly influence the input of materials to the rest of the channel system." (p. 1366);

d) highly vulnerable to the impacts of upslope activities, because the likelihood for discernible instream effects increases with slope steepness and the erodibility of sideslopes (p. 1367); these smaller headwater streams tend to have steeper and more erodible sideslopes (p. 1371).

Fine sediment supplied to these smaller streams by road impacts is readily transported downstream, thereby cumulatively affecting downstream conditions influenced by streamflow and sediment. The FEIS completely fails to disclose this scientific information regarding the cumulative importance of Class IV streams to downstream conditions, which is a significant flaw. Such headwater streams typically comprise the majority of the stream network; however, the FEIS compounds the failure to assess impacts of road crossings on Class IV streams, by completely failing to provide any sound information on the extent of such streams and the fraction of the stream network comprised by these streams within Project area.[2] For these reasons, the FEIS's failure to assess and make known the total number of stream crossings on Class IV streams under existing conditions and affected by the action alternatives road activities is a fatal defect with respect to peak flows, sediment-related impacts, [3] and consequent effects on salmonids and their habitats.

16. The failure to properly assess and make known the level of road-stream connectivity in subwatersheds under existing conditions and under the proposed alternatives renders the FEIS's assessment of peak flow impacts highly defective. It is well-documented that road-stream connectivity elevates peak flows (e.g. La Marche and Lettenmaier, 2001; Jones and Grant, 1996; Grant et al., 2008). Roads vastly elevate runoff to streams due to extremely low infiltration rates on roads, generating runoff even from low-intensity precipitation, which is delivered to streams at points of hydrologic connectivity, contributing to frequent and enduring elevation of runoff and peak flows. Notably, such alterations of runoff by roads persist for even longer than roads do: even with obliteration, infiltration rates remain low for several years after such treatment (Foltz et al., 2007).

[2] The FEIS's (p. 3-342) inadequate information on the ***known*** length of streams of different classes in the Project area does not provide an sound estimate of the extent of Class IV streams, because the FEIS (p. 3-342) explicitly notes regarding this information that "Class IV streams **greatly under represented** as streams can only be determined by site surveys." (emphasis added) It is, therefore, apparent that the FEIS has failed to even determine the cumulative length and frequency of these streams and, hence, fails to properly assess their cumulative importance with respect to effects on downstream water quantity, sedimentation, and water quality.

[3] As is discussed in greater detail in other sections of this declaration, management-induced sediment delivery contributes to the degradation of a host of stream conditions, including suspended sediment, turbidity, fine sediment levels in stream substrate, width/depth, and pool volume, depth, frequency, and quality (Richards, 1982; USFS et al., 1993; Rhodes et al., 1994; Spence et al., 1996; USFS and USBLM; 1997). Notably, degradation of these sediment-affected stream conditions in salmonid habitats reduces the survival and production of all salmonid species inhabiting streams in the Project area, including pink, coho, sockeye, chum, and chinook salmon and cutthroat, steelhead, and Dolly Varden trout (Krueger, 1981; Everest and Meehan, 1983; Meehan, 1991; USFS et al., 1993; Rhodes et al., 1994; Spence et al., 1996; USFS and USBLM; 1997; Suttle, 2004).

17. Although the FEIS cites the USFS's "state-of-science" report on the effects of forest practices on peak flows (Grant et al., 2008), the FEIS fails to make known that Grant et al. (2008, p. 39), explicitly stated regarding peak flow impact assessment (emphasis added):

> "Determining where the proposed treatment falls within this range requires an assessment of the intrinsic basin condition and intensity of proposed management action…For example, the **existing and proposed road network should be evaluated with respect to its degree of connectivity with the stream network**…"

Thus, the FEIS's failure to properly assess road-stream connectivity directly conflicts with the USFS's own guidance regarding the proper assessment of the cumulative impacts of roads on peak flows, although this is never made known in the FEIS.

18. The failure of the FEIS to properly assess road-stream connectivity and resulting flow impacts is significant because these effects can significantly increase sediment delivery to downstream fish habitats. Peak flow alteration by roads tends to be most pronounced in smaller subwatersheds, such as those for smaller streams, as the USFS's own literature and assessments have noted (Gucinski et al., 2001; Grant et al., 2008; Drake et al., 2008), resulting in increased channel erosion in headwater streams, as USFS research has noted (King, 1989). Even relatively small changes in short duration peak flows in headwater streams can significantly increase downstream sedimentation because channel erosion and sediment transport are exponentially affected by streamflow (King, 1989; Dunne et al., 2001). Increased channel erosion due to increased runoff from roads in small headwater subwatersheds also accelerates mass failures occurrences (Montgomery, 1994), thereby increasing downstream sedimentation.

19. There are several reasons why the FEIS's failure to properly assess road-stream connectivity under existing conditions and the action alternatives is a terminal defect with

respect to assessing sediment-related impacts from roads to aquatic systems under the alternatives. It is well-documented that rates of soil erosion from roads are orders of magnitude higher than on undamaged soils on a per unit basis, due to bare soils, soil compaction, and the greatly elevated surface runoff. Cut and fill slopes associated with roads also typically undergo elevated erosion, adding to sediment loads from road surfaces. Concentrated road runoff in ditches can elevate sediment levels in runoff from roads still more. This sediment-laden water is delivered to streams very efficiently at road-stream connections.

20. Little can be done to effectively reduce runoff and sediment delivery from roads at stream crossings (Kattlemann, 1996), as the USFS has repeatedly conceded. For instance, the Plumas National Forest Travel Management FEIS (2010) noted: "Road/stream crossings are significant sources of sedimentation on [Forest Service] lands. Even well-drained roads and trails will likely deliver some amount of surface-generated sediment to stream channels at crossings." Therefore, it is clear that road crossings elevate sediment delivery to the channel network. However, the FEIS fails to even provide a reasonable index of these impacts, because it does not provide estimates of road crossings on Class IV streams by alternatives at the subwatershed scale.

21. Gullies connecting roads to streams not only efficiently deliver sediment to streams, but can also increase sediment loads delivered to streams via gully erosion triggered by road runoff, which can be a significant source of anthropogenic sediment loads (Reid et al., 2010), although this is not made known in the FEIS. The FEIS fails to provide a reasonable index of these impacts, because it fails to make known the amount of existing road that is relatively proximate to streams at the subwatershed scale.

The FEIS does not adequately assess and make known the magnitude, duration, and extent of sediment delivery due to the construction, reconstruction, and *subsequent decommissioning/storage of some of these roads in the Project area under the alternatives.*

22. The FEIS's (p. 3-270) baseless assertion that road construction under the action alternatives only result in short-term increases in sediment supplied to streams is in direct conflict with available scientific information regarding the persistence and magnitude of sediment impacts due to road construction (e.g., USFS et al., 1993; Rhodes et al., 1994; USFS and USBLM, 1997; Beschta et al., 2004). Although it is not adequately made known in the FEIS, it is well-documented that the construction of roads, including "temporary" roads, vastly and immediately elevates erosion and subsequent sediment delivery, particularly in the first few years after construction. However, road erosion remains enormously elevated relative to undisturbed areas for many decades, even with decommissioning or obliteration (Beschta et al., 2004), as USFS assessments and cumulative effects methods acknowledge (Potyondy et al., 1991; USFS et al., 1993; Menning et al., 1996). Even many decades after obliteration, erosion rates on roads remain well above natural rates, as USFS cumulative effects methods indicate (Potyondy et al., 1991; Menning et al., 1996).[4] Reconstruction of unused or previously decommissioned roads also greatly elevates road erosion and subsequent sediment delivery in a highly persistent fashion (Beschta et al., 2004), although this is also not adequately disclosed in the FEIS. For these reasons, the proposed road construction and reconstruction under the action alternatives would cause major, enduring increases in sediment delivery to streams due to the high level of stream-road connectivity in the Project area, although the FEIS fails to properly make known the persistence of these significant impacts.

[4] USFS and USBLM, 1997b, Chapter 3, Effects of proposed alternatives on aquatic habitats and native fishes, *in* Evaluation of EIS Alternatives by the Science Integration Team. Vol. I PNW-GTR-406, USFS and USBLM, Portland, OR, notes that the approach in Menning et al. (1996) regarding the road-related cumulative impacts to watersheds were consistent with the USFS's experts' assessments of the sediment-related risks from these activities.

23. The FEIS compounds these flaws by failing to provide any information on the likely level of the action alternatives' constructed and reconstructed roads' connectivity with streams, which strongly affects the magnitude of sediment delivery from such roads. The FEIS does not even provide a reasonable index of these impacts by alternative because it does not provide any assessment of the amount of crossings of Class IV streams by constructed and reconstructed roads or provide a notion of the amount of roads proposed for construction and reconstruction near (<300 feet) streams, and, hence, likely connected to streams, by subwatershed under the action alternatives. Due to these defects, the FEIS fails to reasonably asses and disclose the cumulative impacts of road construction and reconstruction on sediment delivery to streams under the alternatives at the scales of subwatersheds, watersheds, and the Project area. The FEIS also fails to reasonably differentiate among the alternatives with respect to sediment impacts from road construction and reconstruction due to the same defects.

24. The FEIS fails to adequately assess and disclose that roads that are put into storage and/or decommissioned will continue to significantly elevate sediment delivery to streams for several decades. Even over many years such roads undergo nominal recovery in the key attributes that cause elevated sediment delivery (Beschta et al, 2004): infiltration and vegetative cover. Notably, the USFS's own research indicates that even with obliteration treatments, which likely contribute more to road recovery than storage and/or decommissioning, infiltration and vegetative recovery is exceedingly minor several years after such treatment (Foltz et al., 2007). Further, efforts to disconnect roads from streams on roads that are proximate to streams are frequently unsuccessful, especially in area with high levels of precipitation (GLEC, 2008), such as the Project area. As we noted in Beschta et al. (2004):

> "Accelerated surface erosion from roads is typically greatest within the first years following construction although in most situations sediment production remains elevated over the life of a road (Furniss et al. 1991; Ketcheson & Megahan 1996). Thus, even 'temporary' roads can have enduring aquatic impacts. Similarly, major reconstruction of unused roads can increase erosion for several years and potentially reverse reductions in sediment yields that occurred with non-use (Potyondy et al. 1991). Where roads are unpaved or insufficiently surfaced with erosion resistant aggregate, sediment production typically increases with increased vehicular usage (Reid & Dunne 1984)…Furthermore, the assumption that road obliteration or BMPs will offset the negative impacts of new road and landing construction and use is unsound since road construction has immediate negative impacts and benefits of obliteration [or decommissioning] accrue slowly."

Therefore, it is clear that roads that are decommissioned, closed, and/or stored will continue to contribute elevated sediment to streams for decades, particularly such roads that are proximate to streams, although this is not adequately assessed and made known in the FEIS's assessment of the cumulative watershed effects of the action alternatives.

The FEIS did not properly assess and make known the magnitude and extent of increased sediment delivery due to the elevated use of roads under the action alternatives.

25. The FEIS's failure to adequately assess and make known the magnitude, duration, and, extent of increased sediment delivery from roads due to increased road use under the action alternatives is a severe defect, because the Project will increase road traffic for log haul on many roads for many years under the selected alternative. Many of these roads are hydrologically connected to streams.

26. Increased road use elevates sediment production by producing highly mobile fine sediment on road surfaces, rutting road surfaces, and the disrupting of gravel or aggregate surfaces. The mobile fine sediment on the road surfaces produced by road traffic is easily transported to streams by runoff that inevitably occurs on roads in response to even relatively minor rain or snowmelt events.

27. Studies have repeatedly documented that increased logging traffic on unpaved roads greatly elevates sediment delivery to streams (Reid and Dunne, 1984; Foltz, 1996; Luce and Black; 2001; Gucinski et al., 2001; Beschta et al., 2004). In western Washington with a climate similar to the Project area, graveled roads used by more than four logging trucks per day generated more than 100 times the sediment delivered to streams than roads with light use and more than 1,000 times that from abandoned roads (Reid et al., 1981; Reid and Dunne, 1984). Even with a road surface of crushed rock aggregate, which is often used with the intent to reduce sediment production, Foltz (1996) documented that elevated log haul traffic increased sediment production by 2 to 25 times that on unused roads in western Oregon. Foltz (1996) noted that a similar range of increases due to road traffic was likely in other regions, because the mechanisms causing the effect are similar among regions. Luce and Black (2001) also documented that increased sediment production from elevated traffic on roads surfaced with rock aggregate. Although it is not disclosed in the FEIS, the USFS's summary of road impacts (Gucinski et al., 2001) concluded that "…rates of sediment delivery from unpaved roads are . . . closely correlated to traffic volume." Therefore, increases in road traffic under the action alternatives would increase sediment production and delivery, especially from roads that are hydrologically connected to streams.

28. Road traffic when roads are wet increases sediment delivery from roads still more. Reid (1998) estimated the use of graveled roads during wet weather increased the duration of higher instream turbidity from elevated road erosion by about 30-40%.

29. Traffic on wet roads contributes to the development of ruts, which increase erosion by concentrating road runoff (Foltz, 1996). Rut development increases sediment delivery from surface erosion on roads by about 2-5 times that on unrutted roads (Burroughs, 1990; Foltz and Burroughs, 1990).

30. Ruts increase sediment delivery from roads for as long as the ruts persist, even after road use declines or ends. Thus, rutting of roads by traffic when roads are wet significantly increases sediment loads in runoff from roads in a persistent fashion. This increase in sediment delivery from use when roads are wet is over and above the highly elevated levels caused by the existence of roads.

31. Vehicular traffic on wet roads can negate or greatly reduce the effectiveness of efforts to limit sediment delivered to streams. For instance, the use of wet roads often destroys or damages drainage features, such as water bars, and other attempts to reduce road-stream connectivity. Wet weather reduces the bearing strength of road surfaces, leading to submerging of gravel or aggregate into the native road surface under the weight of vehicles and/or pumping finer material below gravel to the road surface (Fu et al., 2010), returning the treadway to a more native-surfaced condition. The physical effects of road traffic also result in the lateral displacement of gravel or aggregate from the treadway, resulting in a more native-surfaced condition, which further elevates sediment delivery from trafficked roads.

32. Significant road traffic, especially on wet roads, can increase the need for more frequent road maintenance, which can elevate sediment delivery from roads. Grading and ditch

maintenance elevate road erosion and sediment delivery considerably (Luce and Black, 2001; Sugden and Woods, 2007). Although the FEIS (pp. 3-272, 3-285) acknowledges that ditch-cleaning will occur under the selected alternative, the FEIS does not disclose that it adds to Project's cumulative increase in sediment delivery to streams.

33. The FEIS is devoid of a quantitative assessment of the duration, location, extent, and magnitude of increased sediment delivery due to road traffic and maintenance. The FEIS does not even provide any reasonable index of these effects on sediment delivery under the alternatives, because the FEIS does not identify the extent of the road network that will be subjected to increased road traffic, including during periods when roads are wet. The FEIS also fails to make known the amount of roads with high levels of stream connectivity subjected to elevated haul, such as those roads near streams or that cross Class I through Class IV streams, at the scale of subwatersheds, watersheds, and the Project.

34. The FEIS's failure to properly assess increased sediment delivery due increased road use and maintenance is extremely significant for several reasons. Roads are typically the single largest source of surface erosion and fine sediment in managed watersheds. Fine sediment is the sediment caliber that is most deleterious to salmonids. The Project will plainly subject many roads with a high level of stream connectivity to considerable increases in log haul and other road use for several years. For these combined reasons, the FEIS has not reasonably assessed the impacts of Project's action alternatives on sediment delivery to streams and consequent impacts on stream conditions, fish habitats, and fish populations.

The FEIS does not properly assess and make known the magnitude and extent of elevated sediment delivery due to the construction, reconstruction, and use of logging landings under the action alternatives.

35. Logging landings have impacts on vegetation, soils, erosion, and subsequent sediment deliver that are akin to those of roads in their persistence and severity (Karr et al., 2004), as a USFS cumulative effects method also indicates (Menning et al., 1996). The FEIS's failure to assess the sediment impacts of landings under the alternatives is a severe defect because, on a per unit basis, landings sediment impacts similar to roads (Menning et al., 1997; Beschta et al., 2004) and can deliver sediment over considerable distances. In their study of sediment travel distance from forest management activities, Ketcheson and Megahan (1996) found that the longest travel distance of sediment originated from a landing. As we noted in Karr et al. (2004) (emphasis added):

> "Construction and reconstruction of roads and **landings** damage soils, destroy or alter vegetation, and accelerate the runoff and erosion harmful to aquatic systems…Logging, **landings**, and roads in riparian zones degrade aquatic environments by lessening the amount of large wood in streams, elevating water temperature, altering near-stream hydrology, and increasing sedimentation."

Landings essentially "zero-out" soil productivity in an irreversible manner (Geppert et al., 1984), although this is not disclosed in the FEIS.

36. Although the action alternatives would require the construction and reconstruction of many landings, the FEIS's section on the cumulative watershed effects (CWE) of the alternatives is devoid of any assessment of the effects of landings at any scale. The FEIS compounds this major omission by failing to provide the locations, number, and total area of existing landings, and those proposed for construction and reconstruction under the action alternatives, at the scale of watersheds and relatively proximate (<300') to streams. Due to the

lack of the latter, the FEIS does not provide any reasonable index of landing impacts on sediment delivery to affected streams.

37. The FEIS's failure to assess and divulge the number, total area, and locations of landings that will be reconstructed, constructed under the action alternatives is significant due to the persistence and intensity of landings effects on sediment delivery. Like roads, once landings are constructed, recovery of impacted areas is not rapid, even with remediation efforts, resulting in persistent elevation of erosion and sediment delivery. Other USFS assessments (Bitterroot National Forest, 2001, Rogue River and Siskiyou National Forests, 2003) have acknowledged that, as with roads, the loss soil properties and productivity on landings is irreversible because they are unlikely to fully recover even with remediation efforts.

38. Second, the failure to assess and divulge the number, location, and area of landings is a significant defect because of the likely number and total area of landings under the action alternatives. Typically at least one landing is needed per logging unit. Therefore, the action alternatives would involve the reconstruction and construction of a very large number of landings.

39. The total area of these landings is likely to be highly significant. Analyses of numerous logging projects indicate that area of landings typically comprises 1.5-2% of the area logged. Using the low value in this range (1.5%) together with the area proposed for logging under the selected alternative (ROD, p. 4), it is likely that the area of landings for the selected alternative would be about 127.3 acres, most of which will be either constructed or significantly reconstructed. Because landings have similar impacts as roads on a per-unit-area basis, it is likely this level of landings will have soil and watershed impacts that are akin to the reconstruction or construction of about **26.3** miles of road with mean width of 40 feet, which is

extremely significant, yet undisclosed in the FEIS with respect to its cumulative watershed effects, which would certainly be considerable.

40. The FEIS's lack of information on the locations of landing is also a major problem. Landings are often located in flatter terrain for logistical reasons, which often results in their being constructed relatively close to streams, where the potential for connectivity is high. For these combined reasons, the FEIS's failure to properly make known the number, area, and location of landings are highly significant defects. These defects are compounded by the failure of the FEIS to properly assess and make known erosion and sediment delivery impacts of landings, which renders its assessment of sediment impacts under the action alternatives unsound.

The FEIS does not reasonably evaluate and disclose existing impacts to riparian systems, particularly those from landings and roads, combined with action alternatives' landing and road activities in riparian areas.

41. Proper evaluation of riparian conditions and impacts is essential to assessing the cumulative effects on streams and salmonid habitats and populations. Riparian conditions profoundly affect stream and salmonid habitat conditions, as legions of studies have noted (e.g., Meehan et al., 1991; USFS et al., 1993; Rhodes et al., 1994; Erman et al., 1996; Moyle et al., 1996; USFS and USBLM, 1997a). Roads, logging, and landings in riparian areas persistently degrade stream and salmonid habitat conditions in several ways that greatly decrease the survival and production of salmonids, including those with habitats in streams draining the Project area. However, the FEIS does not adequately evaluate and disclose existing riparian conditions and the action alternatives' impacts on them, due to a few key defects.

42. First, as previously discussed, the FEIS does not provide any data on the riparian areas occupied by existing and past roads and landings. This is a key defect because landings

and roads degrade numerous riparian functions in an extremely persistent fashion. Such functions include the provision large woody debris (LWD), thermal regulation, bank stability, and sediment detention (Meehan, 1991; USFS et al., 1993; Rhodes et al., 1994; Erman et al., 1996; USFS 1997a; b). The recovery of these riparian functions in areas occupied by roads and landings is nominal over many decades, even with non-use, due the irreversible loss of soil productivity caused by soil compaction and the irretrievable loss of topsoil. The FEIS (p. 3-530) acknowledges roads cause irreversible and irretrievable losses of soil productivity. Roads and landings in riparian areas are also long-term sources of elevated sediment delivery, as previously discussed. Therefore, it is absolutely essential to assess and make known the existing amount of riparian area occupied by landings and roads at the scale of watersheds and subwatersheds in order to reasonably assess and divulge cumulative effects on aquatic systems. For these same reasons, assessment and disclosure of the amount of riparian area that will be permanently damaged by road and landing construction under the action alternatives at the scale of watersheds and subwatersheds is necessary to evaluate in order to reasonably assess cumulative effects and adequately differentiate among the alternatives.

43. However, the FEIS provides no information on the amount of riparian areas occupied by landings and roads under existing conditions or that would be constructed or reconstructed under the action alternatives. This is a severe defect for several reasons. First, it is highly likely that a considerable amount of riparian areas are occupied by roads and landings. Major haul routes are typically located in riparian areas near streams. It is also likely landings occupy a significant fraction of riparian zones in many subwatersheds which have had an extremely high fraction of riparian areas logged, such as following subwatersheds: Cobble Cr. (40% of riparian area logged), Deer (65% of riparian area logged), Eagle Cr./Slide Cr. (64% of

riparian area logged), Gravelly Cr. (44% of riparian area logged), Little Ratz Cr. (53% of riparian area logged), Sal Cr. (56% of riparian area logged), Thorne River Intertidal (62% of riparian area logged, Tiny (53% of riparian area logged), and Torrent (56% of riparian area logged) (FEIS, p. 3-274). Therefore, the failure to assess existing landings in riparian areas in these subwatersheds is a major defect in the assessment of the cumulative effects in these subwatersheds.

44. It is highly likely that selected alternative (Alt. 3) would involve a significant amount of road construction and reconstruction in riparian areas because the selected alternative involves such activities on numerous stream crossings on Class I through Class III streams (FEIS, p. 3-291). However, the FEIS's estimates of stream crossings do not provide an index of the amount of riparian area occupied by landings and roads, because the former likely doesn't correlate with stream crossings. The FEIS's stream crossing data does not include crossings on Class IV streams, which cumulatively affects downstream conditions. Thus, the FEIS does not provide an index of the total amount of riparian areas occupied by roads and landings. The riparian harvest estimates are also unlikely to provide a reliable index of the riparian areas occupied by roads and landings, because a considerable amount of riparian roads are not directly associated with nearby riparian harvest, but rather, logging throughout the subwatersheds.

45. Second, the long-term damage to the functionality of riparian systems by roads and landings contributes to the degradation of a variety of stream conditions that reduce the survival and production of salmonids. Roads and landings within one site-potential tree height of streams cause long-term diminishment of stream shading, contributing to elevated water temperatures, which are already a problem for salmonids in several streams in the Project area (FEIS, p. 3-275). Roads and landings within one site-potential tree height of streams cause long

term loss of in-stream LWD, which is already a significant problem in several project area streams, due to high levels of logged riparian areas (see: ¶ 43 of this declaration), contributing to the loss of in-channel sediment detention in headwater streams and in-stream cover and reduced pool quality, volume, and frequency (USFS et al., 1993; Rhodes et al., 1994; McIntosh, 2000; Buffington et al., 2002). Notably, field research has shown that in SE Alaska, LWD levels are lower, in a statistically significant fashion, in some stream types draining logged and roaded watersheds than in undisturbed watersheds (Bryant et al., 2004),[5] indicating that riparian impacts have significantly reduced LWD levels, although this important information is not disclosed in the FEIS. Temperature and LWD impacts adversely affect salmonid populations and their habitats, resulting in reduced survival and production of affected salmonid populations (Meehan, 1991; USFS et al., 1993; Rhodes et al., 1994; USFS and USBLM, 1997a; McCullough, 1999).

46. Roads and landings in riparian areas also cause long-term increases in sediment delivery, which has numerous adverse impacts on water quality and salmonid habitats. Elevated sediment delivery causes the loss of pool volume, depth, quality, and frequency (Lisle and Hilton, 1992; USFS et al., 1993; Rhodes et al., 1994; Buffington et al., 2002; McIntosh et al., 2000). It also impedes pool development (Buffington et al., 2002). The loss of pool depth from sedimentation has been shown to be correlated with increased levels of fine sediment in streams caused by increased sediment delivery (Kappesser, 2002). USFS et al. (1993) concluded that increased sediment delivery from roads was one of the primary causes of the extensive pool loss on public lands throughout western Oregon, Washington, and northern California. McIntosh et al. (2000) noted that elevated sediment delivery from land management activities was major cause

[5] Bryant et al., (2000) found that reductions LWD in some stream types in roaded and logged watersheds relative to unmanaged ones are statistically significant at $p<0.10$. Due to variability and the consequences and probability of erroneously assuming there is no effect when there actually is one, a much higher p-value (e.g., $p<0.20$) and, hence lower minimum detectable effect size, is warranted (Peterman, 1990; Rhodes et al., 1994).

of the loss of large pools in many streams throughout the Columbia River basin. The loss of pool volume, frequency, and quality significantly diminishes the productivity of salmonid habitats, as USFS researchers have repeatedly noted (Meehan et al., 1991; USFS et al., 1993; USFS et al., 1997a; Reeves et al., 1997; McIntosh et al., 2000). Field studies in SE Alaska have shown that pool depths and pool frequency are lower, in a statistically significant fashion, in some stream types draining logged and roaded watersheds than in undisturbed watersheds (Bryant et al., 2004),[6] which strongly indicates that the loss of LWD and increased sediment delivery has degraded pool habitats in the Project area. However, the FEIS completely fails to disclose this peer-reviewed information on the impacts of logging, roads, and landings on pool conditions.

47. Elevated sediment delivery from roads and landings near streams also causes increases in fine sediment levels in stream substrate, as repeatedly documented in both field studies and laboratory experiments (Eaglin and Hubert, 1993; Rhodes et al., 1994; Huntington, 1998; Buffington and Montgomery, 1999; Hassan and Church, 2000; Kappesser, 2002; Cover et al., 2008). Increases in fine sediment in streams are particularly likely when the increases in sediment delivery are primarily comprised of fine sediment, as is the case with that from surface erosion from roads and landings. Notably, field studies in SE Alaska have shown that stream substrates are finer, in a statistically significant fashion, in some stream types draining logged and roaded watersheds than in undisturbed watersheds (Bryant et al., 2004),[7] indicating that elevated sediment delivery has degraded fish habitats in the Project area. However, the FEIS not

[6] Bryant et al., (2000) found that reductions in pool depths and pool frequency in managed watersheds relative to unmanaged ones are statistically significant at $p<0.10$. As previously discussed, a much higher p-value (e.g., $p<0.20$) for statistical significance, and, hence lower minimum detectable effect size, is warranted (Peterman, 1990; Rhodes et al., 1994).

[7] Bryant et al. (2000) documented that differences in stream substrate size between unmanaged watersheds and those are roaded and logged watersheds are statistically significant at $p<0.10$ in some stream types. As previously discussed, a much higher p-value (e.g., $p<0.20$) for statistical significance, and, hence lower minimum detectable effect size, is warranted (Peterman, 1990; Rhodes et al., 1994).

only fails to disclose these important findings, but erroneously cites the findings as providing evidence that there is no statistical relationship between logging activities and substrate conditions, which is wholly misleading.

48. Increased levels of fine sediments in streams negatively affect salmonid survival and production in several ways (Meehan, 1991; Rhodes et al., 1994; Waters, 1995; USFS et al., 1997a). Increases in fine sediment in streams sharply reduce the survival and production of all salmonid species inhabiting streams within the Project area, but cutthroat trout, which inhabit streams in the Project area, undergo especially sharp drops in egg-to-emergent survival with increased levels of fine sediment (Weaver and Fraley, 1991). Research indicates that *any* elevated level of fine sediment significantly impairs the production of steelhead trout (Suttle et al., 2004), which inhabit Project area streams.

49. Increased sediment delivery increases stream width and decreases stream depth in depositional reaches (Richards, 1982; Dose and Roper, 1994), which is also associated with reduced pool dimensions (Buffington et al., 2002). Dose and Roper (1994) identified increased sedimentation from roads and logging as one of the primary causes of the statistically significant increase in channel width in watersheds subjected to forest removal and roads in southwestern Oregon. Increases in width/depth ratio increase summer water temperatures (Beschta et al., 1987; Rhodes et al., 1994). Bartholow (2000) estimated that the increases in channel width documented by Dose and Roper (1994) significantly increased summer water temperatures, even in the absence of any reduction in stream shading. Notably, field studies in SE Alaska have shown that stream width/depth is higher, in a statistically significant manner, in some stream types draining logged and roaded watersheds than in undisturbed watersheds (Bryant et al.,

2004),[8] indicating increased sediment delivery has degraded channel form and water temperatures in the Project area.

50. For these combined reasons, the FEIS's failure to properly assess and divulge roads and landings within a site-potential tree height of *all* streams in riparian area at the scale of subwatersheds and watersheds is a severe defect. Because the FEIS also failed to evaluate and make known the amount of landing and road construction in riparian zones, it did not adequately differentiate among the alternatives or properly assess cumulative effects of the alternatives on aquatic resources.

51. The FEIS's (p. 3-274) estimates of riparian area logged in subwatersheds in the Project area may not fully capture the negative effects of past logging on riparian functions, and, hence, cumulative aquatic effects. This is because logging within a site-potential tree height of streams or floodplain degrades the riparian functions of LWD provision and maintenance of stream temperatures the sediment regime (USFS et al., 1993; Rhodes et al., 1995; Murphy, 1995; NRC, 1996; Erman et al., 1996; USFS et al., 1997a). Therefore, it is critical to assess the amount of area logged within one site-potential tree height of all streams or floodplains. There is no indication that in the FEIS or the Watershed Resources Report (James, 2013) that the logged riparian area estimates in the FEIS include *all of the* area logged within one site-potential tree height of *all streams* within the Project area.

52. The anecdotal information in the unit and road cards regarding riparian conditions is not a surrogate for the proper cumulative assessment and disclosure of riparian conditions within the Project area. The information in these cards is innately segmented and much is

[8] The differences in width/depth between unmanaged watersheds and those are roaded and logged watersheds are statistically significant at $p<0.10$ (Bryant et al., 2004). As previously discussed, given variability and the consequences and probability of erroneously assuming there is no effect when there actually is one, a much higher p-value (e.g., $p<0.15$) for statistical significance, and, hence lower minimum detectable effect size, is warranted (Peterman, 1990; Rhodes et al., 1994).

qualitative. At a minimum, a cumulative assessment of the riparian information in these cards would require quantitative aggregation of riparian condition at the scale of subwatersheds and watersheds, which is what should have been done in the FEIS, but was not. Although such an effort would have been tractable during the development of the DEIS and FEIS, it is not tractable for the interested public do such a necessary analysis during the time period allotted for review and comment on the FEIS.

The EA fails to reasonably evaluate and disclose that available scientific information indicates the Project's "no-cut" buffers on Class I through Class III will not eliminate the selected alternative's significant and persistent impacts to aquatic systems, including salmonid populations and habitats.

53. There are four primary reasons why the Project's proposed no-cut areas along streams will not eliminate the selected alternative's impacts on aquatic resources to levels and/or duration that are insignificant. First, as previously discussed, a significant, although undisclosed, amount of riparian areas on Class I- III streams will be damaged by road construction and road reconstruction, as evidenced by the stream crossing estimates for the selected alternative (FEIS, p. 3-291). It is likely that many of the constructed and reconstructed roads will occupy still more riparian areas, especially those along Class IV streams, for which no road crossing data are provided in the FEIS.

54. Impacts at or near stream crossings are not abated by the Project's no-cut buffers, because the roads pierce these buffers. A no-cut buffer does not exist between roads and streams at stream crossings. Simply enough, streamside vegetation and protection zones that are functionally destroyed by road construction or reconstruction cannot arrest the impacts of such activities. Therefore, a no-cut buffer has no significant effect on the persistent impacts caused by road construction and reconstruction at or near stream crossings, including the impacts on sediment delivery, runoff, LWD, stream shading, and water temperatures. As previously noted,

crossings are long-term, major sources of sediment delivery that are not amenable to elimination (Kattlemann, 1996), as USFS assessments have acknowledged (Plumas National Forest, 2010; Sante Fe National Forest, 2010). Although the FEIS completely fails to disclose it, field studies have demonstrated that fine sediment levels in streams are increased by stream crossings in a statistically-significant fashion (Eaglin and Hubert, 1993).

55. Stream crossing construction and reconstruction activities will remove vegetation along streams at and near a number of stream crossings, although this is not disclosed or analyzed in the FEIS. The vegetation removed at and near stream crossings provides shade and microclimate regulation that is vital to water temperature maintenance (Beschta et al., 1987; USFS et al., 1993; Rhodes et al., 1994); its removal will increase water temperatures (Beschta et al., 1987; McCullough, 1999). The FEIS also fails to include any sort of reasonable examination of the effect of constructing and reconstructing stream crossings in the Project area on water temperatures, although such crossings typically elevate summer water temperatures.

56. The negative effects on water temperature from vegetation removal are persistent. In the absence of soil damage, about 25-40 years are needed for the full recovery of stream shade after vegetation removal (Beschta et al., 1987; Rhodes et al., 1994). However, the soil damage caused by roads significantly retards the regrowth of vegetation, increasing the persistence of impacts on water temperatures.

57. Stream crossing construction contributes to increased water temperatures in other ways. Although undisclosed in the FEIS, road runoff that is delivered to streams at stream crossings and other points that are hydrologically connected to streams elevates stream temperatures during summer runoff events (National Research Council (NRC), 2008). This is because runoff occurs in response to even small precipitation events and this runoff is heated by

warm road surfaces during summer. Notably, this thermal pollution from roads occurs when streams are already relatively warm due to seasonal effects, elevating the adverse impacts on salmonids (Meehan, 1991; Rhodes et al., 1994; McCullough, 1999). Although undisclosed in the FEIS, examinations of the effects of road density and density of stream crossings in multiple watersheds have verified that stream temperatures tend to increase with increasing density of roads and stream crossings (Nelitz et al., 2005). This is likely due to the combined impacts of roads and road crossings on water temperatures, including shade loss, subsurface flow disruption, channel widening, and warmed runoff contributions. By completely ignoring this source of water temperature elevation due to stream crossings, the FEIS failed to reasonably make known the inadequacy of stream protection measures. In so doing, the FEIS also failed to reasonably examine the total impacts of the action alternatives on water quality, salmonid habitat, and salmonid populations.

58. The construction of roads within one site-potential tree height of streams also irreversibly robs streams of LWD. Such impacts are extremely persistent due to the loss of soil productivity, causing long-term loss of LWD provision. These are serious impacts because many of the area streams already have depressed LWD levels. This situation is likely to continue to deteriorate due to high levels of past riparian logging. The survival and production of salmonids inhabiting streams affected by the action alternatives are negatively affected by LWD loss.

59. Second, a significant amount of riparian areas are already severely damaged by existing and past roads, landings, and logging, although the amount of existing and past roads and landings near streams is not made known in the FEIS. However, the FEIS completely fails to reasonably assess or make known the severe long-term degradation of riparian functionality

caused by past and existing roads and landings, including the long-term loss of LWD provision and water temperature moderation, together with greatly elevated sediment delivery. All of these impacts of existing degradation of riparian conditions strongly affect the survival and production of salmonids.

60. The impacts from existing and past landings are extremely persistent. The USFS has conceded that soil productivity cannot be rapidly restored on roads and landings (Bitterroot National Forest, 2001; Rogue River and Siskiyou National Forests, 2003). The damage to soil productivity on constructed, reconstructed, and existing roads and landings within a site-potential tree height of streams will preclude or severely stunt the growth of trees that can ultimately provide instream LWD. Therefore, LWD levels are likely to continue to deteriorate in affected streams. The damage from existing roads and landings near streams also persistently retards the re-establishment of vegetation that provides the stream shade and microclimate regulation needed for the maintenance and restoration of water temperatures.

61. Third, the FEIS fails to properly assess and divulge that the lack of no-cut riparian areas on Class IV streams will contribute to cumulative downstream degradation in a persistent fashion. Roads, landings, and logging along these streams elevate sediment delivery and streamflows, as previously discussed. The loss of LWD in Class IV streams also cripples sediment storage in headwater systems, resulting in elevated routing of sediment to downstream reaches. It can also reduce downstream LWD levels (May and Gresswell, 2003), as the FEIS (3-275) acknowledges. Vegetation removal along headwater streams also cumulatively affects downstream water temperatures (Allen and Dietrich, 2005).

62. The FEIS also does not properly disclose that numerous scientific assessments have noted that small headwater streams, such as those typed Class IV by the TNF, should be

provided with protected riparian widths that are *at least* as great as downstream reaches due to the sensitivity of these headwater streams and their cumulative importance to downstream habitat conditions (Rhodes et al., 1994; Moyle et al., 1996; Erman et al., 1996; USFS and USBLM, 1997a). The FEIS fails to disclose that USFS's own assessments have recommended protected widths along smaller headwater streams of *at least* one site-potential tree height (USFS et al., 1993; USFS and USBLM, 1997a) in order to limit downstream degradation from roads, logging, and landings near headwater streams. These evaluations indicate that the protection measures for numerous, sensitive, and cumulatively important Class IV streams under the Project are inadequate and will result in persistent and significant degradation of an array of fish habitat attributes that affect the survival and production of the salmonid populations that inhabit Project area streams.

63. Fourth, the streamside "no-cut" buffers along Class I through Class III streams are not wide enough to obviate the impacts of upslope impacts or to fully maintain riparian functions essential to the maintenance of unimpaired aquatic habitat conditions. Numerous assessments, including those of the USFS (USFS et al., 1993; USFS and USBLM, 1995; 1997a), have indicated that at least 300 feet of undisturbed vegetation is needed to prevent sedimentation from unchannelized sediment delivery from upslope sources. Roads and landings near streams can generate create channelized flows of sediment that are travel many hundreds of feet. Thus, the no-cut widths of vegetation along Class I through Class III streams under the Project are not adequate to eliminate sediment delivery in channelized flows from roads, landings, and logging. For these reasons, the no-cut widths of vegetation along Class I through III streams under the Project are not sufficient to prevent significant and persistent increases in cumulative sediment delivery from logging, landings, and roads under the selected alternatives. Scientific information

amply indicates that there is a high degree of certainty that the lack of adequate riparian protection under the Project together with the landing and road activities in riparian areas under the selected alternative will appreciably degrade riparian functions and aquatic resources, contrary to the cursory statements in the FEIS.

64. Although it is not disclosed in the FEIS, the retention of all vegetation along streams for a distance of *at least* one site-potential tree height is necessary to maintain nearly natural levels of stream temperature moderation and provision of LWD recruitment (USFS et al., 1993; Rhodes et al., 1994; USFS et al., 1997). There is no indication in the FEIS that the width of no-cut areas along streams corresponds to at least the height of a site-potential tree. Therefore, the no-cut widths along streams under the Project are unlikely to maintain unimpaired levels of LWD recruitment and stream temperature moderation.

65. The FEIS fails to make the foregoing information regarding stream protection widths known. The FEIS compounds this significant omission by failing to soundly examine the ineffectiveness of the Project's no-cut riparian widths and make known that the are inadequate.

The FEIS fails to adequately assess and make known the cumulative effects of existing conditions together with the impacts of the alternatives on fish habitats and populations.

Water temperature

66. The FEIS has numerous defects with respect to the assessment of water temperature impacts. It failed to take a hard look at the cumulative impacts of:

- the Project's permanent and irreversible of removal of stream shading and stream microclimate regulation due the construction and reconstruction of stream crossings and other road segments with one site-potential tree height of all streams;

- the Project's cumulative effects on increasing stream width via the combined impacts of elevated peak flows and sediment, which can significantly elevate water temperatures, even in the absence of shade removal (Bartholow, 2000);
- stream shade removal on Class IV streams.

67. These defects are compounded by the failure to properly assess existing conditions that cumulatively affect water temperatures, including the cumulative loss of riparian shading and microclimate regulation due to roads, landings, and logging.[9] Although the FEIS provides estimates of past riparian logging, the FEIS completely fails to provide any quantitative assessment of how much this logging has elevated water temperatures, although this has been eminently tractable for decades (Thuerer et al., 1984; Thuerer et al., 1985; Bartholow, 2000).

68. The lack of data on current water temperatures in the affected subwatersheds and watersheds exacerbates the foregoing defects. Many USFS assessments have noted that the assessment of existing conditions is essential to evaluating cumulative effects (e.g., Sante Fe National Forest, 2010; Plumas National Forest, 2010; Mt. Hood National Forest, 2012). For instance, Mt. Hood National Forest (2012) acknowledged:

> "…existing conditions reflect the aggregate impact of all prior human actions and natural events that have affected the environment and might contribute to cumulative effects."

69. The FEIS fails to provide data on existing water temperatures for all affected subwatersheds, so the FEIS fails properly assess the effects of existing water temperature conditions combined with those from the selected alternative. Less than 40% of the

[9] As previously discussed, the FEIS's estimates of past riparian harvest does not capture the loss of riparian vegetation due to landings and roads in riparian zones, which persistently elevate water temperatures.

subwatersheds and watersheds have any sort of condition surveys (FEIS, p. 3-258).[10] Further, the condition surveys appear to have involved only a few reaches in the surveyed subwatersheds and watersheds. Temperature monitoring does not appear to have been part of any of these surveys (FEIS, p. 3-258). Therefore, the FEIS lacks the water temperature data needed to reasonably assess the cumulative water temperature impacts on salmonids in all affected subwatersheds. This is significant because, for instance, a water temperature increase of 0.5^{o}F has far more profound impacts on salmonid survival and productivity when existing temperatures are near lethal levels than when water temperatures are well below lethal levels (McCullough, 1999).

70. The paucity of water temperature information is a problem compounded by the lack of stream surveys in subwatersheds with high levels of past riparian logging and, hence, likely significantly elevated water temperatures. Subwatersheds without stream surveys include: Cobble Cr. (40% of riparian area logged), Deer (65% of riparian area logged), Little Ratz Cr. (53% of riparian area logged), Thorne River Intertidal (62% of riparian area logged), Tiny (53% of riparian area logged), and Torrent (56% of riparian area logged) (FEIS, p. 3-274).

71. The failure to properly assess water temperature is a major flaw in the FEIS's assessment of cumulative effects on salmonid populations, survival, and production. Although there is little data available, water temperatures in some streams in the Project area are already a problem for salmonids, even under natural conditions (FEIS, p. 3-275), indicating that some

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[10] The FEIS (p. 3-258) indicates that "Proper Functioning Condition" (PFC) assessments were done in a few reaches in three (Eagle Creek, North Thorne River, and North Big Salt Lake, which, perplexingly, is both a subwatershed and watershed) of the 13 watersheds affected by the Project. PFC surveys in were done in a few reaches in four (Sal, Gravelly, Falls, and North Big Salt Lake) of the 13 subwatersheds affected by the Project (FEIS, p. 3-258). Tier II surveys were done in a few reaches in four (Eagle Creek , Sal Creek, Big Ratz and North Thorne River) of the 13 watersheds affected by the Project (FEIS, 3-258). In aggregate, this information indicates only about 38% of affected watersheds and about 31% of affected subwatersheds have had some conditions in few reaches surveyed. Therefore, the FEIS lacks reasonable data on existing conditions in affected streams that are crucial to proper cumulative effects assessment.

streams in affected subwatersheds are highly susceptible to temperature elevation due to riparian canopy loss from logging, roads, and landings. This information also indicates that additional incremental increases in summer high water temperatures are likely to adversely affect the salmonid species inhabiting Project streams. These impacts are likely to exacerbated further due increases in water temperature caused by global climate change (Beschta et al., 2012).

72. Water temperature elevation negatively affects the production and survival of all of the salmonids in the Project area in numerous ways (McCullough, 1999; McCullough, 2010). Elevated water temperatures have significant acute and chronic negative impacts on pink, coho, chinook, sockeye, and chum salmon that inhabit the Project area streams (FEIS, p. 3-345), including loss of suitable habitat, thermal passage barriers, increased competition by species tolerant of warmer temperatures, reduced egg survival during incubation, and increased susceptibility to disease (McCullough, 1999; 2010). Increased water temperatures have similar negative impacts on steelhead, cutthroat, and Dolly Varden trout (McCullough, 1999; 2010) that inhabit streams in the Project area (FEIS, p. 3-345). Dolly Varden require quite cold water and are particularly unable to tolerate increased water temperatures (McCullough, 1999) Due to the foregoing defects related to water temperature impacts and conditions and their importance to the production and survival of salmonids, the FEIS fails to reasonably assess and make known the cumulative impacts of the selected alternative on the salmonid populations affected by the Project.

LWD

73. The FEIS did not adequately assess the cumulative impacts of the following on LWD in streams:

- the magnitude of the Project's irreversible elimination of LWD recruitment from areas affected by the construction and reconstruction of stream crossings and other road segments with one site-potential tree height of streams;
- the magnitude of irretrievable loss of LWD recruitment from past logging within one site-potential tree heights of streams;
- the magnitude of the irreversible loss of LWD recruitment due existing and past roads and landings that are within one site-potential tree heights of streams.[11]

74. These defects are exacerbated by FEIS lack of systematic information on LWD levels in streams in all affected subwatersheds. Less than 40% of the subwatersheds and watersheds affected by the Project have any sort of condition surveys (See footnote 10). Based on the limited information in the FEIS, the condition surveys only involved a few reaches in surveyed subwatersheds and watersheds.

75. The paucity of LWD information is a problem compounded by the lack of stream surveys in subwatersheds and watersheds with high levels of past riparian logging and, hence, likely significantly depressed LWD levels. Subwatersheds without stream surveys include: Cobble Cr. (40% of riparian area logged), Deer (65% of riparian area logged), Little Ratz Cr. (53% of riparian area logged), Thorne River Intertidal (62% of riparian area logged), Tiny (53% of riparian area logged), and Torrent (56% of riparian area logged) (FEIS, p. 3-274). Notably, a couple of these unsurveyed subwatersheds and watersheds would have LWD levels depressed further in an enduring fashion via road construction at stream crossings under the selected alternative, including Deer Cr. and Little Ratz Cr.(FEIS, p. 3-291). Due to lack of information

[11] As previously discussed, the FEIS's estimates of past riparian harvest do not capture the loss of riparian vegetation due to landings and roads in riparian zones, which persistently eliminate the provision of LWD from such areas.

on LWD conditions, the FEIS fails properly assess the effects of existing LWD conditions combined with those from the selected alternative.

76. The FEIS is devoid of any estimate of existing LWD loss due to past and existing riparian impacts although such estimates are eminently tractable (Gregory et al., 1991; Rhodes et al., 1994). The FEIS could have roughly estimated existing LWD loss by simply using mean level of trees per acre in riparian zones, combined with the riparian area logged in a subwatershed, together with the reasonable assumption that about 50% of trees within one site-potential tree height would ultimately become instream LWD. For instance, in Deer Creek about 294 acres of riparian area has been logged (FEIS, p. 3-274). Using a conservative assumed stocking rate of 120 trees per acre and an instream LWD recruitment fraction of 50%, yields an estimated loss of about 17,640 pieces of LWD due to past impacts in the Deer Creek subwatershed. This very rough estimate indicates that LWD loss has been significant and that more refined estimates are tractable and should have been included in the FEIS.

77. The failure to properly assess LWD impacts is a major flaw in the FEIS's assessment of cumulative effects on salmonid populations, survival, and production. Studies have consistently documented that LWD serves irreplaceable functions in streams that are essential to maintenance of salmonid habitat quality and the survival and production of salmonids (e.g., Gregory et al., 1991; Meehan, 1991; USFS et al., 1993, Rhodes et al., 1994; McIntosh et al., 2000; Buffington, 2002). As we noted in Karr et al., (2004):

> "…large trees …provide habitat for many species, reduce soil erosion, aid soil formation, and nourish streams as their leaves fall or their trunks decay (Henjum et al.1994)….**there is no debate about the key role that large trees play in aquatic systems and many ecological processes**…" (emphasis added).

78. LWD is critically important to pool formation and maintenance of stream complexity (Gregory et al., 1991; Meehan, 1991; USFS et al., 1993, Rhodes et al., 1994; McIntosh et al., 2000; Buffington, 2002; Karr et al., 2004). Pools and channel complexity are vital to salmonid survival and production (Gregory et al., 1991; Meehan, 1991; USFS et al., 1993, Rhodes et al., 1994; USFS and USBLM, 1995; 1997a; McIntosh et al., 2000). LWD also provides instream cover which is important for salmonids (Meehan, 1991; USFS et al., 1993; Rhodes et al., 1994). Reductions in LWD contribute to reductions in populations and production of coho, sockeye, chum, pink, and chinook salmon (Meehan et al., 1991; USFS et al., 1993; Rhodes et al., 1994; USFS and USBLM, 1997a) that inhabit affected streams in the Project area (FEIS, p. 3-345). Loss of LWD also has negative impacts on steelhead, cutthroat, and Dolly Varden trout (Krueger, 1981; Meehan et al., 1991; USFS et al., 1993; USFS and USBLM, 1997a; Reeves et al., 1997) that inhabit streams in the Project area (FEIS, p. 3-345).

79. Although there is little data in the FEIS on LWD levels, the limited available information, together with information on riparian conditions, indicates that many streams have significant deficiencies of LWD, hampering salmonid production. Due to the defects in the FEIS's analysis of LWD impacts, together with riparian conditions and the importance of LWD to the production and survival of salmonids, the FEIS fails to reasonably assess and make known the cumulative impacts of the selected alternative on the salmonid populations affected by the Project.

Sediment delivery

80. As previously discussed, the FEIS did not adequately assess the cumulative impacts the following on sediment delivery to streams:

- the Project's long-term elevation of sediment delivery to road and landing construction and reconstruction, particularly at *all* stream crossings and within a few hundred feet of all streams;
- the elevation of sediment delivery due to increased road use and maintenance, particularly at *all* stream crossings and on roads within a few hundred feet of all streams;
- the long-term loss of elevation of sediment delivery from existing and past roads and landings, especially at *all* stream crossings and from roads and landings within a few hundred feet of all streams.

81. The lack of data on existing sediment-related conditions in affected subwatersheds compounds the foregoing defects in the FEIS related to sediment delivery. As previously discussed, these conditions include channel width/depth, fine sediment levels in substrate, turbidity, and the volume, frequency, depth, and quality of pools. Less than 40% of the subwatersheds and watersheds have any sort of condition surveys and the condition surveys only involved a few reaches in subwatersheds and watersheds. There is no indication in the FEIS that these surveys reasonably and consistently assessed all sediment-related conditions.

82. The lack of information on sediment-related conditions is a problem compounded by the paucity of stream surveys in subwatersheds and watersheds with high levels of road density and/or past riparian logging and, hence, likely significantly elevated sediment delivery. Subwatersheds *without* stream surveys include: Cobble Cr. (40% of riparian area logged), Deer (65% of riparian area logged), Little Ratz Cr. (53% of riparian area logged), Pin (2.1% of area in roads); Thorne River Intertidal (62% of riparian area logged), Salamander (2.9% of area in roads), Tiny (53% of riparian area logged), and Torrent (56% of riparian area logged) (FEIS, p.

3-274). Notably, several of these unsurveyed subwatersheds and watersheds would have sediment delivery elevated further, in enduring fashion due to road construction including at stream crossings under the selected alternative, including Deer Cr, Salamander, Pin, and Little Ratz Cr. (FEIS, pp. 3-287, 3-291). Therefore, the FEIS does not include the information needed to reasonably assess and disclose the cumulative impacts of the Project on sediment delivery and sediment-related conditions in affected subwatersheds. Such surveys are tractable, using accepted methods, but were not done.

83. Studies have consistently documented that elevated sediment delivery degrades several sediment-related conditions in salmonid habitat quality, reducing the survival and production of salmonids. Elevated sediment delivery contributes to loss of pool volume, depth, and frequency (Lisle and Hilton, 1992; USFS et al., 1993; Rhodes et al., 1994; McIntosh et al., 2000; Buffington et al., 2002) which adversely affects all of the salmon and trout species inhabiting streams affected by the Project (Meehan, 1991; USFS et al., 1993, Rhodes et al., 1994; USFS and USBLM, 1997a;b; Reeves et al., 1997). The persistence of the reduction in the quality, frequency, and volume of pools due to wood loss and elevated sediment delivery may be one of the reasons that coastal cutthroat trout do not rebound from watershed disturbance from timber harvest and related activities (Reeves et al., 1997). The loss of pool depth due to elevated sediment delivery also contributes to the loss of thermal refugia for salmonids in deep pools (McCullough, 1999), although this impact is not assessed in the FEIS.

84. Field studies and laboratory experiments have consistently shown that elevated sediment delivery increases fine sediment levels in stream substrate (Eaglin and Hubert, 1993; Rhodes et al., 1994; Buffington and Montgomery, 1999; Hassan and Church, 2000; Kappesser, 2002; Cover et al., 2008). Increases in fine sediment in streams sharply reduce the survival and

production of all salmon and trout species inhabiting streams affected by the Project (Meehan, 1991; USFS et al., 1993; Rhodes et al., 1994; USFS and USBLM, 1997a). Suttle (2004) demonstrated that any incremental increase in fine sediment levels contribute to reduced production of steelhead.

85. Increased sediment delivery also contributes to increases in width/depth of streams (Richards, 1982; Rhodes et al., 1994). Such increases inexorably contribute to elevated summer water temperatures (Bartholow, 2000), although this impact on water temperatures is not examined in the FEIS. Due to the defects in the FEIS's analysis of sediment delivery impacts and sediment-related conditions, together with effects of elevated sediment delivery on the production and survival of salmonids, the FEIS fails to reasonably assess and make known the cumulative impacts of the selected alternative on the salmonid populations affected by the Project.

The FEIS fails to adequately assess and make known the cumulative effects of existing conditions together with the impacts of the selected alternative will have measurable, ecologically-significant, and persistent impacts on salmonid habitats and populations.

86. The FEIS's repeated assertions that the aquatic impacts caused by Project would not be measurable and persistent are without a sound basis. A sound determination of the measurability of impacts requires <u>all</u> of the three following steps: 1) Determine a scientifically-sound threshold for the measurability and significance of the in-stream impact (such as fine sediment, pools, or LWD); 2) Develop a thorough and complete quantitative estimate of the in-stream impact; 3) Compare the sound estimate of the magnitude of the instream impact to the threshold of significance. Notably, the FEIS lacks all three of these steps with respect to the analysis of sediment, LWD, pool, peak flow, and water temperature impacts.

87. The FEIS's assertion of measurability conflicts with available scientific information, including that of the USFS. Studies have consistently documented measurable and persistent degradation of sediment-related stream conditions, including increased fine sediment (Eaglin and Hubert, 1993; USFS and USBLM, 1993; Rhodes et al., 1994; Espinosa et al., 1997; Huntington, 1998; Kappesser, 2002; Bryant et al., 2006; Cover et al., 2008) and the loss of pool depth, frequency, and volume (Lisle and Hilton, 1991; USFS et al., 1993; Rhodes et al., 1994; McIntosh et al., 2000) in response to elevated sediment delivery from the cumulative effects of roads, landings, and logging. While this scientific information is never examined or properly disclosed in the FEIS, it indicates that the action alternatives will persistently and measurably degrade sediment-related conditions in fish habitat, contrary to the cursory assessments in the FEIS.

88. Studies have repeatedly documented that logging and roads near streams elevate water temperatures in a measurable, persistent, and ecologically-significant manner, as the USFS's own large-scale assessments have acknowledged and described (USFS et al., 1993; USFS and USBLM, 1997a), although this information is not examined or made known in the FEIS. Stream crossings and riparian roads have been shown to elevate water temperatures significantly (Nelitz et al., 2007). Although the FEIS does not examine or make this information known, together with information on the effects of activities on water temperatures (e.g., Rhodes et al., 2004; Beschta et al., 1987; McCullough et al., 1999; 2010) and the nature of the selected alternative's riparian activities, this alternative will significantly elevate water temperatures in a persistent and ecologically significant manner.

89. Losses of LWD due to riparian damage from roads are easy to estimate and measure. These losses are also extremely persistent (USFS et al., 1993; Rhodes et al., 1994;

USFS and USBLM, 1997a); the loss of LWD recruitment from such damaged areas is irreversible. For these reasons, the nature of the selected alternative's riparian activities will measurably reduce LWD levels in an enduring manner that will contribute to long-term reductions in salmonid production.

The FEIS does not properly examine and make known that available scientific information indicates that increases in road density harms salmonid populations.

90. The USFS's own assessments have repeatedly found that increases in road density lead to increased degradation of salmonid habitats and reductions in salmonid populations. The USFS's own synthesis of road impacts (Gucinski et al., 2001) noted that there is robust large-scale evidence that increasing road densities and their attendant effects are correlated with declines in the status of some salmonid species. USFS and USBLM (1997a) documented that increases in road density, even at low levels of road density, resulted in reductions in the strength of several populations of resident salmonids. USFS and USBLM (1997) noted that this relationship between road density and salmonid population status was "…consistent and unmistakable…"

91. USFS and USBLM (1997a) found that areas with estimated road densities of <0.1 miles per square mile were most associated with areas of low levels of stream degradation, while areas with estimated road densities of >0.7 miles per square mile were associated with high levels of habitat degradation. Frequency of pools in lower-gradient streams, which are essential aspects of salmonid habitats, declined with increasing road density (USFS and USBLM, 1997a).

92. Extensive habitat and salmonid population surveys done for the Clearwater National Forest, Idaho, found that with few exceptions, native salmonid abundance was higher and fine sediment levels lower in unroaded versus managed landscapes (Huntington, 1998). These differences were largest and most consistent in the lower-gradient channel types, which

are most sensitive to sediment-related road and logging impacts. Other information indicates that increases in stream crossings and riparian road density contribute to elevated water temperatures (Nelitz et al., 2007). In aggregate, this information, which is not made known in the FEIS, indicates that the significant increases road mileage in many subwatersheds under the selected alternative are likely to cause serious and persistent harm to affected salmonid populations.

93. Importantly, the foregoing also indicates that notion that there is not significant harm from sediment-related impacts below a road density threshold of 2.5% of subwatershed area is not valid. Significant harm is likely to occur at far lower levels of road density.

The FEIS did not analyze impacts at ecologically meaningful scales that are adequate for assessing impacts on streamflows, sediment delivery, and fish habitats.

94. There are several reasons why the scale of subwatersheds used for analysis in the FEIS are inadequate to reasonably analyze and disclose impacts on peak flows, sediment delivery and their effects on important aquatic conditions. First, the subwatershed scales used in the FEIS are not based on any sort of stated ecological considerations. The FEIS's subwatershed scales do not appear to correspond to fish production units, stream order, watershed field order,[12] or watershed size. For instance, at least one subwatershed described in the FEIS, North Big Salt Lake, occupies the entire watershed, so it is not really a "subwatershed." The scales of subwatersheds assessed in the FEIS vary widely: the largest "subwatershed," North Big Salt Lake, is more than 38 times larger than the smallest subwatershed analyzed. This vast difference in scales is problematic, especially because significant impacts that are manifest at smaller scales are obscured by analysis of conditions at larger scales. For instance, peak flows in smaller watersheds are more prone to elevation by logging and roads, as previously discussed. Studies have consistently demonstrated that

[12] Subwatershed/watershed scales are commonly delineated in terms of field order on the basis of hydrologic unit codes.

logging activities elevate peak flows in smaller watersheds (MacDonald and Ritland, 1989; Drake et al., 2008).

95. Second, smaller watersheds often have a greater percentage of their watershed area that has been logged and road. This higher percentage of watershed disturbance causes proportionately greater peak flow increases in these smaller watersheds. Due to the patchiness in the distribution of logged areas and roaded areas, analysis at larger scales does not capture the more intensive disturbance levels existing in smaller watershed systems that significantly elevate peak flows. As a team of USFS scientists noted in a review of proposed land management (Drake et al., 2008):

> "Streams are most susceptible to change in peak flows at scales smaller than sixth-field subwatersheds (10,000-40,000 ac) (Grant et al. in press). Because headwater catchments (on the order of 25-250 ac) can experience peak flow changes due to management…it is feasible that individual logged catchments within a sixth-field watershed could have peak flow increases that are masked by uncut catchments sharing the same 6th field subwatershed."

The foregoing indicates that peak flow alteration analysis should be done at scales less than 10,000 acres in order to reasonably assess the Project's impacts on peak flows. Notably, six of the 37 subwatersheds assessed in the FEIS have areas greater than 10,000 acres, including Big Ratz, Control Lake, Goose Creek, North Big Salt Lake, North Kasaan Bay Frontage, and Thorne Lake (FEIS, p. 3-262). Thus, the FEIS's scale of analysis obscures, rather than discloses, the effects of logging on peak flows in headwater systems in smaller portions of large scale subwatersheds analyzed in the FEIS.

96. Due to the patchiness in the distribution of logging and roads, it is likely that significant sediment impacts at smaller scales is also obscured in the larger subwatersheds (e.g., >10,000 ac). This scale issue undermines the soundness of the analysis of the percentage of roads occupying subwatersheds in the FEIS.

97. Third, increases in peak flows in smaller subwatersheds have significant impacts. Some channel types in headwaters are highly vulnerable to increased channel erosion caused by peak flow elevation (Rosgen, 1996). Once degraded, many headwater streams in have very poor prospects for recovery, even after the causes of degradation have been eliminated (Rosgen, 1996). Due to their position in the channel network, elevated erosion in headwater channels increases downstream sediment transport and sedimentation in downstream fish habitats (Montgomery and Buffington, 1998).

98. For these reasons, the FEIS's analysis of peak flows and percentage of area occupied by roads at the scale of quite large subwatersheds is inadequate for assessing and disclosing the impacts on peak flows and sediment delivery under existing conditions and the action alternatives.

The FEIS fails to properly assess the limited effectiveness of the Project's BMP and resulting negative impacts on aquatic systems under the selected alternative.

99. The FEIS compound the defects in the analysis of cumulative effects on aquatic resources by failing to reasonably disclose that Best Management Practices (BMPs) for roads and landings, especially those constructed within a few hundred feet of streams, have very limited effectiveness. Although it is undisclosed in the FEIS, there are no reliable data indicating that BMPs consistently reduce the adverse effects of roads on aquatic resources to ecologically negligible levels, especially within the context of currently pervasive watershed and aquatic

degradation (Ziemer and Lisle, 1993; Espinosa et al., 1997; USFS and USBLM, 1997; Beschta et al., 2004; GLEC, 2008).

100. The nationwide assessment of BMP effectiveness commissioned by the USEPA (GLEC, 2008) specifically noted that BMPs aimed at reducing road impacts are not 100% effective, and, in particular, that efforts to prevent road drainage to streams have considerable potential for failure, especially in the Pacific Northwest. However, the FEIS does not provide any discussion of the known limited effectiveness of road BMPs. GLEC (2008) also notes that in the Pacific Northwest that “conventional BMPs for road construction may not be sufficient to prevent adverse effects on stream channels and fish habitat.”

101. BMPs do not eliminate the adverse impacts of roads on sediment delivery. For instance, BMPs cannot eliminate sediment delivery from roads to streams at stream crossings (Kattlemann et al., 1996; Beschta et al., 2004; Rhodes and Baker, 2008). USFS and USBLM (1997b) noted that it is not possible to log areas without increasing erosion and sediment delivery to streams, regardless of BMPs involved or care in implementation, especially when roads are involved. Based on review of available data, MacDonald and Ritland (1989) concluded that roads typically double suspended sediment yield even with <u>state-of-the-art</u> construction and erosion control and that suspended sediment contributions from surface erosion, alone, from roads in the absence of mass failure, are typically in the range of 5 to 20 percent above background and remain at elevated levels for as long as roads are in use. Notably, this would, in many cases, violate water quality standards for turbidity.

102. There are many impacts that conventional BMPs cannot do much to reduce or arrest, such as the severe adverse effects from high-intensity impacts (e.g. road construction) in sensitive areas, such as stream crossings. As GLEC (2008) noted with respect to road impacts,

"in some cases, however, control of the problem may not be feasible: location 'trumps' management practice." BMPs cannot obviate or significantly reduce the long-term loss of LWD recruitment to streams from roads and landings constructed near streams, which will occur under the selected alternative. Similarly, BMPs cannot eliminate or rapidly arrest increases in water temperature caused by the loss of shade and microclimatic functions in riparian areas affected by road and landings.

103. Activities implemented with somewhat effective BMPs still often contribute to negative cumulative effects on aquatic systems (Ziemer et al., 1991; Rhodes et al., 1994; Espinosa et al. 1997; Beschta et al., 2004; GLEC, 2008). Espinosa et al. (1997) documented that aquatic habitats were severely damaged by roads and logging in several watersheds despite BMP application. Espinosa et al. (1997) noted that blind reliance on BMPs in lieu of limiting or avoiding activities that cause aquatic damage serves to increase aquatic damage.

104. Importantly, the selected alternative fails to include the most effective BMPs, which are:

- avoidance of implementing damaging logging, landing, and road activities in high hazard, sensitive, or degraded areas, such as stream crossings, riparian areas, and unstable terrain, such as earthflows (Rhodes, 1994; Kauffman et al., 1997; Beschta et al., 2004; Karr et al., 2004; GLEC, 2008);
- full protection of an adequate width of riparian areas on *all streams* to prevent or reduce the transmission of upslope impacts to streams (USFS, 1993; Rhodes et al., 1994; Moyle et al., 1996; Erman et al., 1996; USFS and USBLM, 1997a; Beschta et al., 2004; Karr et al., 2004).

The avoidance of high impact activities in sensitive terrain has long been recognized as far more effective than attempting to reduce such impacts via BMPs, which have very limited effectiveness. Avoidance of sensitive areas is critical, due to the effects that impacts in such locations promulgate (USFS et al., 1993; Rhodes et al., 1994; Beschta et al., 2004; GLEC, 2008).

105. It has long been recognized that *full* protection of the area of vegetation within 200 to >300 ft of the edge of *all* stream types is one of the most important and effective ways to limit the impacts from upslope logging-related disturbances, as numerous independent assessments have repeatedly concluded, including, to but not limited to, USFS et al. (1993), Henjum et al. (1994), Rhodes et al. (1994), NRC (1996), Erman et al. (1996), Moyle et al., 1996; USFS and USBLM (1997a; b), Beschta et al. (2004), and Karr et al. (2004). However, despite this information, the selected alternative fails to incorporate these effective BMPs.

106. For these reasons, the FEIS fails to reasonably examine the Project's likely cumulative impacts on aquatic systems, because the FEIS fails to reasonably assess the limited effectiveness of the Project's BMPs.

The FEIS does not identify several irretrievable and irreversible impacts of the selected alternative.

107. The FEIS does not make known that the loss of topsoil exported to streams as a result of road and landing construction is both irretrievable and irreversible (Beschta et al., 2004). In a similar vein, the FEIS fails to properly divulge that the loss of soil productivity on constructed landings is irreversible.

108. The FEIS does not make known that the loss of key riparian functions, including LWD provision and moderation of water temperatures is an irreversible and irretrievable loss from riparian areas subjected to landing and road construction. The FEIS also fails to make

known that the loss of the production of salmonids due to the cumulative adverse impacts of the selected alternative on salmonid habitats is irretrievable.

Summary and Conclusions

109. The FEIS did not properly assess peak flow and sediment impacts because it failed to properly assess the connectivity of streams and roads. It also failed to assess these impacts due to improper analytical scales.

110. The FEIS did not properly assess water temperature and LWD impacts because it failed to properly assess duration and magnitude of the impacts of past logging, existing and past landings and roads in riparian areas on water temperatures and LWD levels. The lack of information on existing instream LWD and water temperature conditions also precludes reasonable assessment of the Project's cumulative impact on LWD and water temperature.

111. Due to the importance of LWD, sediment-related conditions, and water temperature to the survival and production of salmonids, the FEIS did not reasonably assess and make known the cumulative effects of the action alternatives on salmonid survival and production.

112. The FEIS failed to incorporate and make known a wide variety of scientific information which indicates that existing conditions together with the cumulative impacts of the selected alternative will cumulatively contribute to long-term aquatic degradation and losses in the survival and production of salmonid species inhabiting affected streams within the Project area.

113. The FEIS does not adequately divulge that the selected alternative will result in several types of irreversible and/or irretrievable commitments of important resources, including

losses of: salmonid habitat quality, salmonid production, topsoil, LWD, and riparian functionality.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

Executed this 12th day of August 2013 in Portland, Oregon.

JONATHAN J. RHODES

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